

REVIEW OF RECENT ONSHORE SEISMIC DATA

PEL.8, SOUTH AUSTRALIA

PART I DECEMBER 1977 - PART II JANUARY 1978

FOR

ALLIANCE OIL DEVELOPMENT AUSTRALIA N.L.



S.J. Watson  
December 1977

PEL.8 (SOUTH AUSTRALIA)PART I

1. INTRODUCTION
2. RECENT ONSHORE DATA
3. CONCLUSIONS
4. RECOMMENDATIONS

PART II

NOTE TO ACCOMPANY MAP OF THICKNESS OF LOWER  
OTWAY GROUP

-----

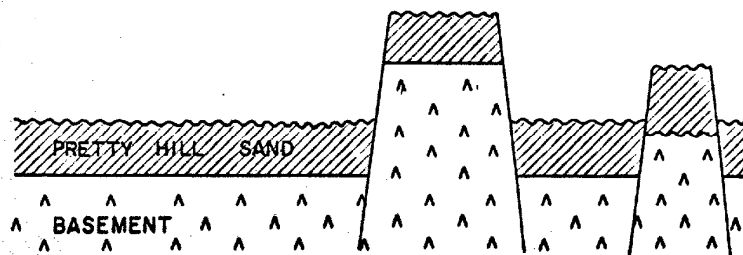
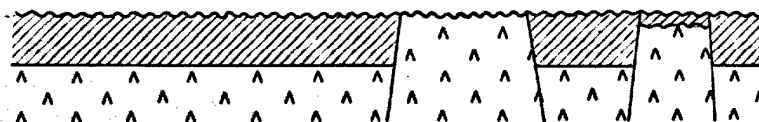
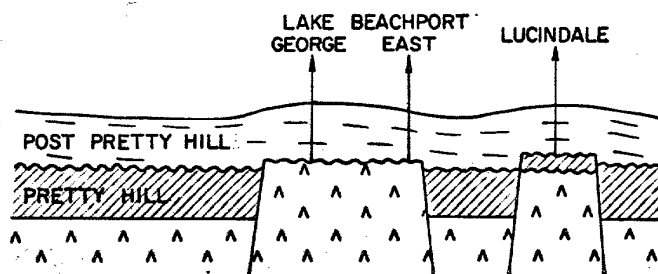
- |           |   |
|-----------|---|
| PLATE I   | Shot Point Map  |
| PLATE II  | Structure Map-Contours on a reflector<br>tentatively assigned to the base of<br>"Post Pretty Hills" unconformity. |
| PLATE III | Isopach Map. Approximate thickness of<br>Lower Unit, Lower Cretaceous, in feet.                                   |

## 1. INTRODUCTION

The structure and development of continental margins, and in particular the southern margin of Australia, have been well studied, and the extensive marine seismic data used in support of the studies have been correlated, on the basis of very poor ties, to seismic data of the onshore Otway Basin. It is here considered that the onshore areas have been subjected to tectonic events that differ from those plainly evident in the off-shore areas.

The seismic reflection that was previously regarded as "top of Pretty Hill sand" is seen to be more reasonably taken to be "Base of the post Pretty Hill depositional cycle". The reflection changes its identity as it is followed across the onshore basin, and a tectonic mechanism is devised to explain it.

Test wells onshore may be classified as (a) those which have found only thin sections of the bottom of the Pretty Hills sand, and (b) those that encountered none at all. Despite this, seismic evidence shows that over 6,000 feet of sediments exist in the "lows". The identity of the sediments is unknown, but they should include the Otway Group, including the Pretty Hills sand, and even perhaps earlier material.

STAGE 1STAGE 2STAGE 3FIG. 1

Simplified schematic diagram showing (Stage 1) massive basement uplifts, with (Stage 2) massive erosion, followed by (Stage 3) post Lower Cretaceous sedimentation and basement rejuvenation.

## 2. RECENT ONSHORE DATA

Onshore data of moderate value includes many traverses of single-fold reconnaissance lines that meandered along roads and tracks, and served to show that the gravity high anomalies had anticlinal expression in the sediments above them.

Recent multi-fold stacking was used by Esso Standard Oil (Australia) Pty. Ltd. to provide limited (and sometimes inadequate) details of the main anticlinal features. The lines involved are:-

- a. Esso 069A-1 to 11 and 14 to 24.
- b. Esso 071A-1 to 7 and 12 to 17
- c. Esso Marine Traverses EU-1, 2, 4A, 5
- d. Esso Playbacks of Lucindale Traverses  
A, B, C, D, E, F, G.

A reflection thought to belong to top of the Pretty Hills Formation was then carried from the offshore survey, tied to neighbouring onshore traverses, and contoured over the onshore area.

Exploration drilling at Esso Lake Eliza No. 1, Esso Lake George No. 1, Henry Resources Beachport East No. 1 and Henry Resources Diamond Swamp No. 1 proved that the assumption, that the reflector represented the Pretty Hills, was not valid in many places onshore.

An alternative structural history of the onshore area is pictured here. It is illustrated in Figure 1, which assumes a untilted basement for pictorial purposes. Large vertical basement movements occurring at a time when the Pretty Hills (or at least its lower part) was already laid down, carried the sands with them. The basement uplift may have included the injection of magma. After this Stage 1, vigorous erosion, acting for a period of variable duration, peneplained the area completely until Stage 2 was reached. This marked the end of Neocomian, and further Lower Cretaceous sedimentation, then proceeded until the rift onset unconformity occurred.

The basal Sherbrook sand (Waarre Formation) then ushered in the upper Cretaceous, which period was in turn ended by the break-up unconformity at the base of Palaeocene.

All sediments of post-Pretty Hills age were later affected in various degrees by rejuvenation of the old basement fault lines.

This series of events explains why the "Pretty Hills reflector", carried to the onshore region by correlation, seems to indicate only small, perhaps imperceptible, change in character as it passes across basement highs where, in fact, no Pretty Hills exists. As an example, Stage 3 of Figure 1 demonstrates how Lake George No. 1 and Beachport East No. 1, when drilled on a Pretty Hills play found only basement. Lucindale No. 1 met a veneer of basal Pretty Hills before entering basement.

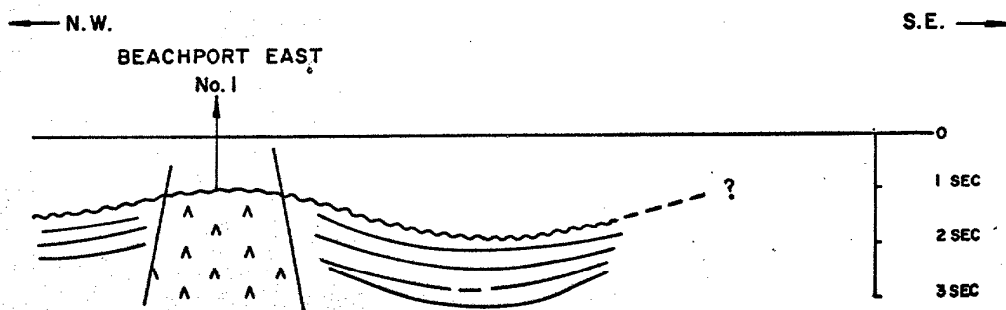
An examination of the Esso 069A and 071-A multifold seismic surveys shows that the traverses were laid in the field so as to cover rather inadequately the main structures of interest at that time. The so-called Pretty Hill reflector soon becomes replaced by the basement reflector, or its equivalent in a group of refraction noise elements, below which there are no more reflections. This serves to outline huge areas where the Pretty Hills is absent; and these areas, given the titles of Camel Back, Diamond Swamp, Mount Hope and Beachport can be ruled out as prospective areas. Lucindale and Lake Eliza features have been tested and shown to have thin Pretty Hills overlying basement. The Konetta and Sugarloaf axes are not properly defined.

A contour map, based on a reflector tentatively assigned to the top of the Pretty Hills, or perhaps more appropriately to the base of post-Pretty Hills sedimentation, accompanies this report. The reflector, at places other than basement, i.e. where there is plenty of section below it, has been chosen as the best reflector under the Sherbrook or Upper Cretaceous.

There is considered to be a large element of uncertainty in this way of making an identification, but there is no good tie between seismic traverses in the field, and therefore the contour map must be regarded as tentative only.

Features of interest on this map are:-

1. Lack of good quality data where good quality is most needed.
2. The presence of large, oval "bald headed" anticlines, e.g. Camel Back, Diamond Swamp, Mount Hope and Beachport, of no prospective interest.
3. The presence of oval features, e.g. Lucindale and Lake Eliza, with thin Pretty Hills sand on them, and therefore of only very minor interest.
4. The presence of vaguely suggested features, e.g. Konetta and Sugarloaf that require more seismic effort.
5. The presence of synclines (here called "rim-type") associated with Diamond Swamp, Mount Hope and Camel Back.
6. An area of confused data between Beachport and Diamond Swamp.
7. The presence of many large faults, not shown, at the boundaries of the "bald headed" structures.
8. The presence of very thick sediments, of unknown identity, between the "bald headed" structures, as shown diagrammatically in Figure 2.



**FIG. 2**

Section (diagrammatic) through Beachport East No. 1 showing thick sediments of unknown identity immediately off the "bald headed" anticline of Beachport. Section taken from traverse 069A-2.



3. CONCLUSIONS

1. There is inadequate seismic information for providing coverage of the "Pretty Hill" reflector.
2. There is inadequate well control to allow identification of lower Cretaceous reflectors.
3. There is little or no information from the present wells, except of a negative nature.
4. The relationship, if any, between Beachport, Diamond Swamp and Mount Hope is not clear, and the way in which the lower Cretaceous abuts or onlaps them is not clear.
5. It is likely that stratigraphic and fault traps exist at the sides of the "bald headed" structures.
6. The area of "confused" data between Beachport, Diamond Swamp and Mount Hope could well conceal a lower Cretaceous feature that is not bald headed.
7. Two small features at Lake George are within reasonable drillable depth, but are very imperfectly outlined.

4. RECOMMENDATIONS

The following recommendations are put forward:-

1. Exploration should be directed towards clarifying the thickness and structural attitude of the lower Cretaceous Otway Group, including its basal sand member, (the pre-rift basin sediments).

2. If the Sherbrook Group (rift valley basin) (Upper Cretaceous) thickens eastward it should also be made a target of secondary importance.
3. Off-structure drilling must be contemplated in order to identify the sediments in the deeper parts of the onshore basin.
4. Multifold seismic effort is needed to tie the present data together and to clarify the fault systems bounding the bald headed features.
5. Konetta and Sugarloaf should be outlined by at least two seismic traverses each.
6. Anticlinal features should be regarded as of no importance unless they enclose a thick series of rift valley basin sediments. Traps associated with the extensive faulting due to vertical basement movements must be considered as prime targets.
7. As the prospect goes southeastward into Victoria, the exploration philosophy may require modification owing to the increasing amount of rift valley basin sediments (Sherbrook Group) entering the section.

REVIEW OF RECENT ONSHORE SEISMIC DATA

PEL.8, SOUTH AUSTRALIA

PART II

Note to Accompany Map of Thickness of  
Lower Otway Group (Plate III)

S.J. Watson  
January 1978

### THE PROBLEM

The problem may be concisely stated:

Does the Crayfish (= Pretty Hills) sand present an exploration target in the onshore areas of the Otway Basin?

### A SOLUTION

The answer is in the affirmative, but some qualification is needed.

A study of seismic and well data in the offshore basin supports the idea that the Otway Group of sediments belongs to a basin that existed at the pre-rift time when Australia and Antarctica were a single structural unit. The contents of the basin are generally held to be river-lake deposits, including a basal unit of clean sands penetrated in Pretty Hills No. 1 and Crayfish No. 1.

After a period of severe basement faulting and block adjustment, a severe erosional period occurred and the Lower Cretaceous sedimentation was at an end.

Gradual regional subsidence, connected undoubtedly with the onset of rifting, left the Lower Cretaceous unconformity ready to receive the next sedimentary phase, namely an Upper Cretaceous pile of river delta sediments consisting of sands, silts, mudstones, clays, carbonaceous material. At the early Tertiary, seafloor spreading began, accompanied by regional subsidence, leading to post-breakup progradation of sediments seawards. Further collapse of the basement in Lower Tertiary led to the formation of the Southern Ocean, accompanied by an extensive build-up of open marine carbonates, a process that is still in operation today.

The main pre-rift basin sediments are of importance in oil exploration. The basal unit of good sands (Lower Cretaceous unit) were correlated, by seismic means, to a reflector that is found at Lake Eliza No. 1 and Lucindale No. 1.

The correlation, by Esso, was done on the basis that it was a good reflection on the seismic maps. However, drilling elsewhere on seismic highs, shows that the "good" reflection becomes the top of a basement high in some places, as at Beachport East No. 1, Lake George No. 1, and Diamond Swamp No. 1. Some high quality seismic work was done before the selection of these well sites, but mainly with the purpose of confirming the presence of the "good" reflection on top of the highs. Only at the ends of the traverses was information gained off-structure, seemingly accidentally, leading to the idea that thick Lower Cretaceous sediments do actually exist in the onshore area.

Two high quality seismic traverses (069A-1 and 071A-2) show the reflector that is probably the unconformity at the top of the Pretty Hills sand covering 6,000 feet or more of good reflecting beds between basement highs.

Unfortunately, there is no definite character by which beds within the Pretty Hills sand can be correlated across the highs. Owing to differential uplift and erosion they could well be different beds of the Lower Cretaceous basin.

Seismic and drilling evidence both seem to agree that the exploration of the pre-rift basin needs to be confined, not to the highs, but to the "valleys" between them.

The present seismic work in the basin includes much old data of little value for this purpose and is apparently directed towards locating "highs", which are no longer considered as targets.

RECOMMENDATIONS

It is recommended that a new phase of seismic investigation should be originated in the Otway Basin in order to determine the extent of the onshore location of the remnants of the Lower Cretaceous sands, and to find a small uplift of the basin floor that did not reach high enough to have the Pretty Hills sand completely eroded from it. The attitude of sands against the margins of the basement uplifts (e.g. Lake George, Beachport, Diamond Swamp, Lucindale, etc.) should be examined for fault traps and pinch-outs, both of which are abundant.

S.J. Watson  
January 1978